

CALIFORNIA ENERGY FLOW IN 1982

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October 26, 1983

Lawrence
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Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

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Abstract

For the second year California's energy picture reflected the nationwide recession and conservation movement. Total use was down to 6.0 quads from 6.4 quads in 1980 and 6.3 quads in 1981. Preliminary data suggest that California usage fell slightly more than that of the U.S. as a whole on a percentage basis. The largest change in primary supply was in crude oil. Oil imports from foreign and out-of-state sources declined 32% and 17% respectively. Despite take-or-pay contracts with oil suppliers, utilities were successful in lowering oil used for power generation by 66%. Abundant hydropower from a wet 1981-2 winter augmented electrical supplies. Natural gas use in the state fell slightly. Power from nuclear sources remained well below historical highs due to continuing problems with the state's two licensed reactors. Purchases from small power producers by utilities (cogeneration, solid waste, wind, solar and small scale hydro) continued. Approximately 10% of new capacity in the next decade is anticipated to come from these sources. The largest cogeneration units to come on line in 1982 were in the 40-60 MW_e range. Geothermal development reached 1GW_e installed capacity.

Introduction

For the past seven years, energy flow diagrams for the State of California have been prepared from available data.⁽¹⁻⁷⁾ They have proven to be useful tools in graphically expressing energy supply and use in the State as well as illustrating the large differences in energy use between California and the nation as a whole.

As far as possible similar data sources have been used to prepare the diagrams from year to year, and identical assumptions⁽²⁾ concerning conversion efficiencies have been made in order to minimize inconsistencies in the data and analysis. In 1981, a major source of data for earlier energy flow charts was discontinued - the Quarterly Fuel and Energy Summary (QF&E), California Energy Commission (CEC). Much of the information formerly collected in QF&E is no longer published. Thus, alternate data sources, such as Department of Energy and the American Gas Association have been used in the present 1982 analysis. We continue to see differences in the data reported by various agencies for the year, thus comparisons of 1982 supply and usage based on new sources with previous years analyses based chiefly on CEC data must be done with reservations. Specifically, different aggregation into industrial/commercial/residential categories apparently has occurred which bars meaningful comparisons. Nonetheless, taken overall some generalizations can be made concerning changes in the energy picture in California. Presumably in subsequent years, closer quantitative analysis and comparison from year to year will again be possible.

DATA SOURCES

Appendices A and B summarize the primary sources used in preparation of this report. California Energy Commission publication Quarterly Oil Report provided data on gasoline, aviation and jet fuel consumption. Draft of CEC's Annual Petroleum Review 1982 was the source for data on crude oil and product imports and product exports. DOE/EIA publication Petroleum Supply Annual 1982 provided some transportation data.

As in past years the Annual Report of the State Oil and Gas Supervisor was the source for crude oil and natural gas production.

Data for electric generation are from the Electric Power Annual 1982 published by DOE/EIA. Data on electrical power imports were obtained from the Quarterly Supplement to CEC's monthly Energy Watch. Out-of-state hydro-electric power is from the Pacific Northwest (Bonneville Power Administration) and the Southwest (principally Hoover and Davis Dams on the Colorado River). The transmitted electrical power from imported hydro sources was derived from the net exchange in interstate transfers; power from out-of-state coal-fired plants is recorded separately by the CEC. Out-of-state coal fired plants are at Four Corners, Farmington, New Mexico; the Navaho Plant at Page, Arizona; and the Mohave Plant, Nevada. Data on electric sales were provided by the California Energy Commission staff.

1980 ENERGY FLOW COMPARED TO PREVIOUS YEARS

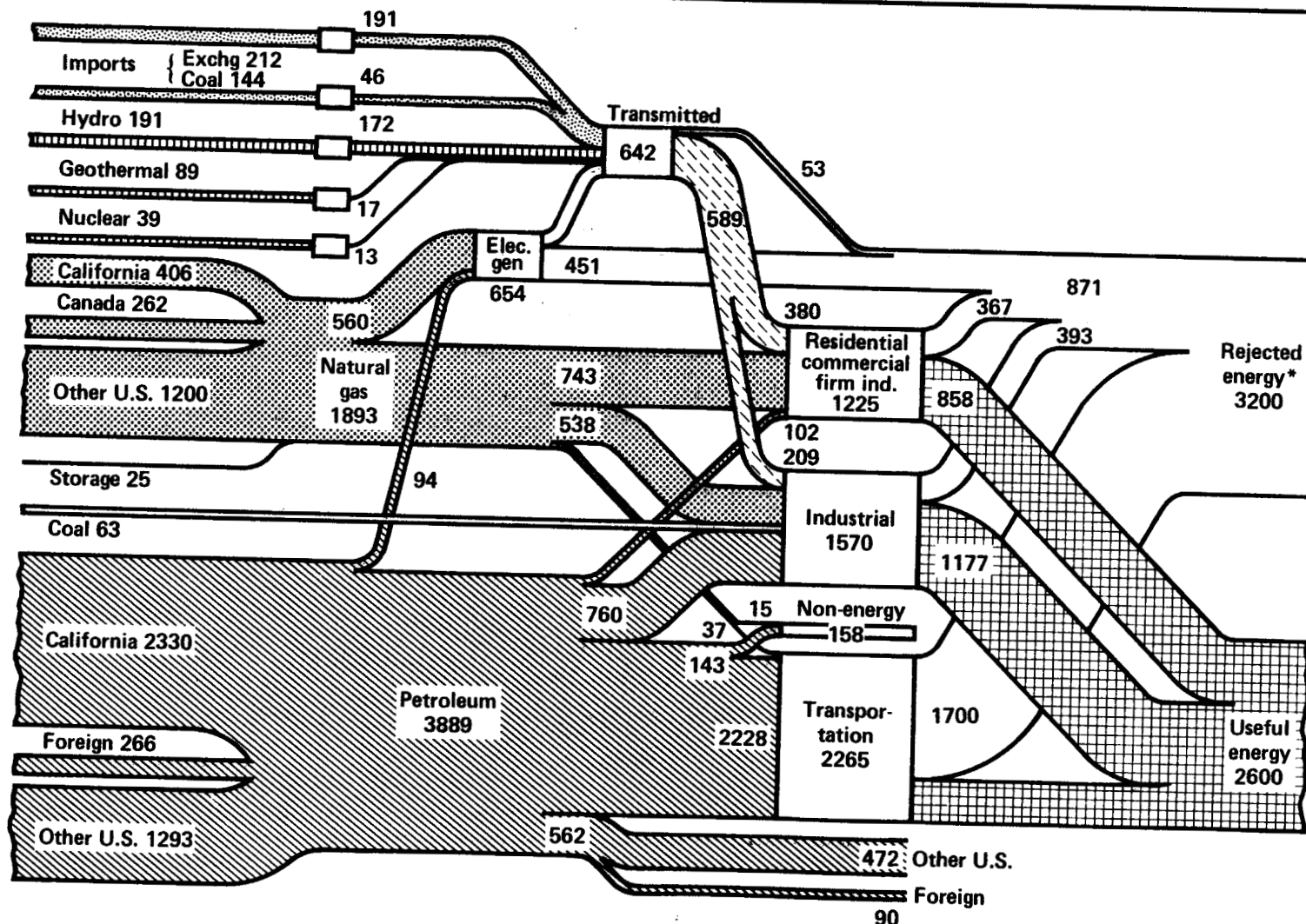
Figure 1 is the flow diagram for 1982 and Figure 2 is for the previous year. Data from other years are compiled in Table 1 for comparison.

Noteworthy changes in the supply in 1982 include:

- o Drop (32%) in imported foreign oil for the second year
- o Another record year for indigenous California oil production
- o Large increase in California hydropower as well as imported power principally from the Pacific Northwest

CALIFORNIA ENERGY FLOW – 1982

TOTAL ENERGY CONSUMPTION 6000×10^{12} Btu



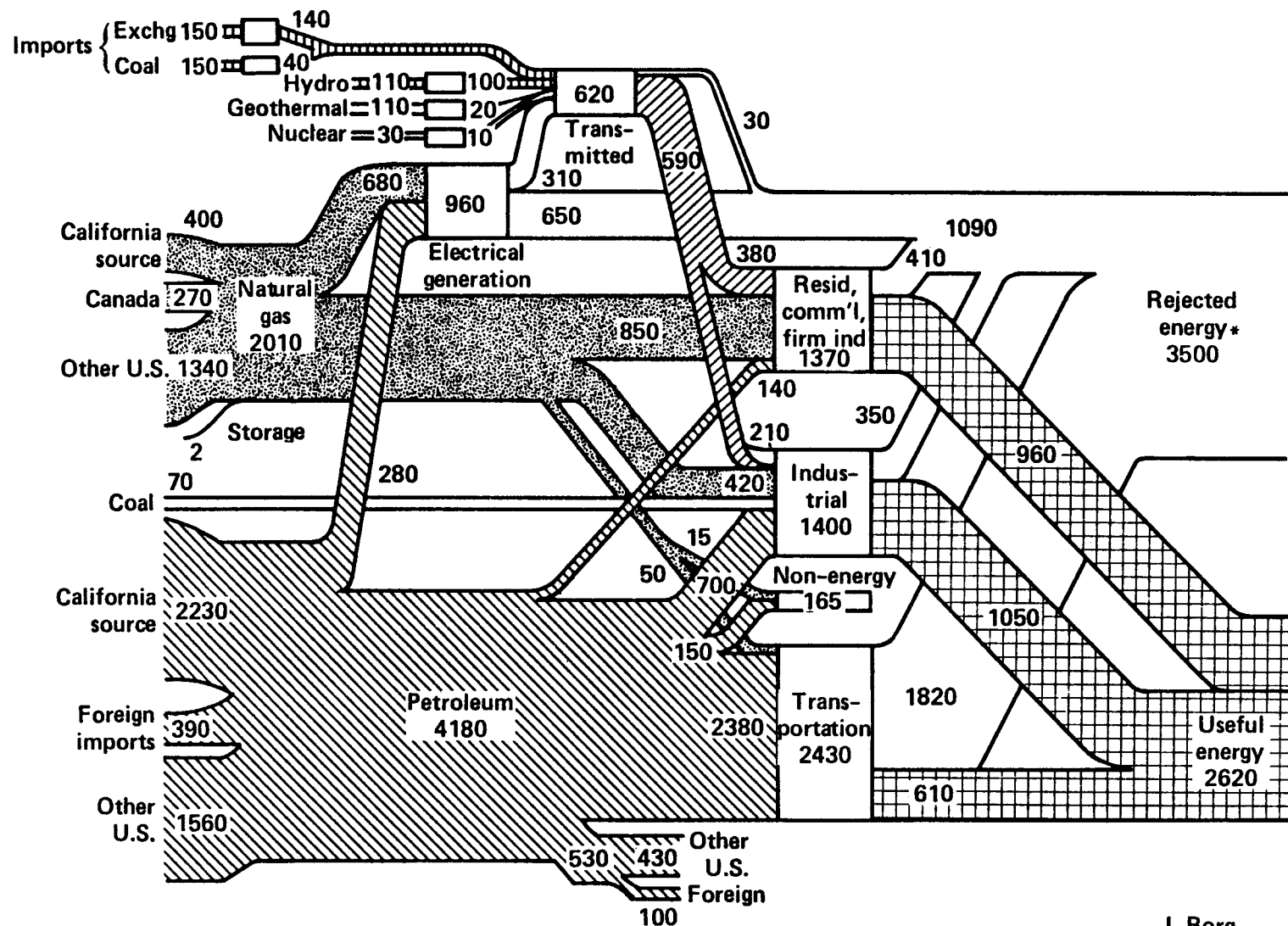
*Includes rejected energy from hydro, coal, geothermal and nuclear conversions
 Data: California Energy Commission; California Division of Oil and Gas; DOE/EIA

C. Briggs/I. Borg

Figure 1

CALIFORNIA ENERGY FLOW – 1981

TOTAL ENERGY CONSUMPTION 6300×10^{12} Btu



*Includes rejected energy from hydro, coal, geothermal and nuclear conversions
 Data: California Energy Commission; California Division of Oil & Gas, DOE/EIA

Figure 2

Table 1

Comparison of Annual Energy Use in California(in 10^{12} Btu)

	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	% change 1981 vs 1982
1980								
Natural Gas	1884	1831	1724	1971	1910	2010	1893	-6
Crude Oil	3886	4516	4379	4587	4391	4180	3889	-7
California Source	1921	2027	2014	2044	2071	2230	2330	+4
Foreign Imports	1606	1875	940	785	591	390	266	-32
Other U.S.	359	614	1425	1758	1729	1560	1293	-17
Domestic/Foreign Exports	630	796	598	620	557	530	562	+6
Net Use	3256	3720	3781	3967	3834	3650	3327	-9
Electricity								
Imports*	158	100	121	92	137	180	237	+32
Imports**	267	208	203	193	252	300	356	+19
Hydroelectric	94	54	144	134	164	110	191	+74
Geothermal and Other	79	63	54	71	93	110	89	-19
Nuclear	51	84	81	96	51	30	39	+30
Gas	303	380	312	458	534	680	560	-18
Oil	619	806	619	640	391	280	94	-66
Total Fuel	1413	1595	1413	1592	1485	1510	1329	-12
Total Transmitted Energy	577	574	597	617	622	620	642	+4
Residential/Commercial/Firm								
industrial	1406	1253	1321	1398	1334	1370	1225	N.V.
Industrial	1162	1248	1088	1216	1294	1400	1570	N.V.
Non-energy	222	221	239	304	298	165	158	-4
Transportation	2004	2199	2438	2478	2471	2430	2265	-7

* As imported MWh (not energy-fuel equivalents)

** As hydroelectric power or coal before conversion to electricity.

N.V. Not valid (see text)

- o Continued decline in use of oil for electric power production - down 85% since 1978

As previously described in Data Sources, due to use of new sources comparison of energy consumption in the various end-use sectors is not valid in all instances. The problem centers on the distinction between industrial and commercial use.

The use in the "non-energy" section remains well below historical highs. This category includes petrochemicals, asphalt, waxes, fertilizer etc.; these uses produce neither heat nor mechanical work. The 1981-1982 decline in non-energy use reflects on the contraction of the fertilizer industry in the state in part due to the increased cost of natural gas under the Natural Gas Policy Act of 1978.

The net decrease in the use of total energy in 1982, 6.3 quads in 1981 compared to 6.0 quads in 1982, is related to the continuing recession. Unemployment in the state involved more than a million people or some 11% of the work force by December (Figure 3).⁽¹⁸⁾ The prime rate dropped from about 16 to 11 1/2% during the year.

For the second year the decrease in energy use had its clearest expression in the decline in the use of crude oil. Foreign imports fell substantially, and even purchase of out-of-state oil fell. In contrast to 1981, use of natural gas also fell. It was displaced by hydropower in the electrical sector. Combined conservation and mild weather (Table 2) in the southern part of the state contributed further to its decreased use. Canadian gas delivered at the border for \$5.06 per thousand cubic feet comprised 14% of the total supply. Other domestic supplies cost about \$3.20. Both sources are considerably cheaper than fuel oil, but because of long term contracts with take-or-pay clauses, utilities were not in all instances able to back out liquid fuel purchases for electric generation.

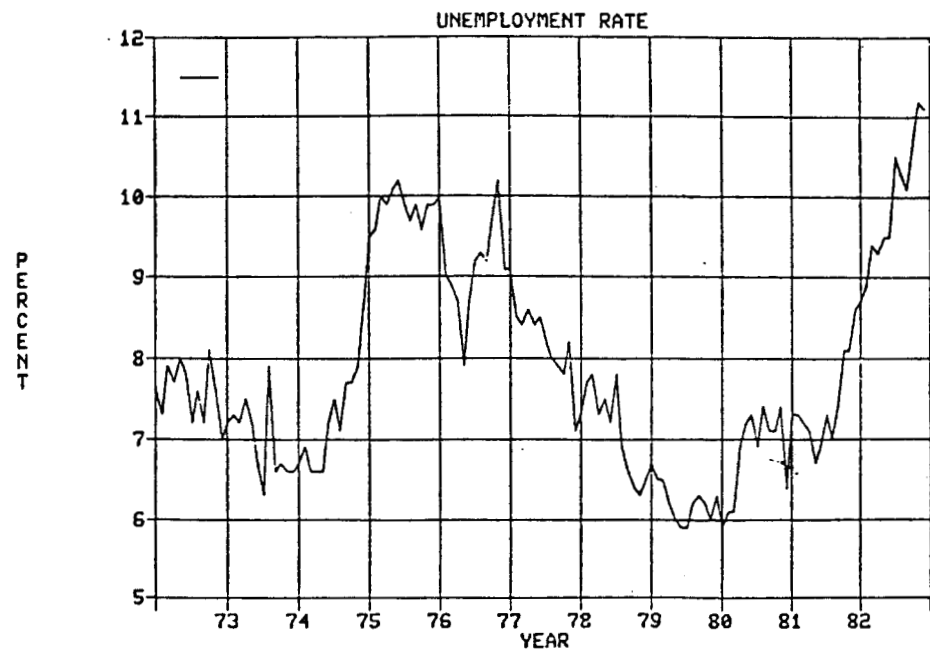
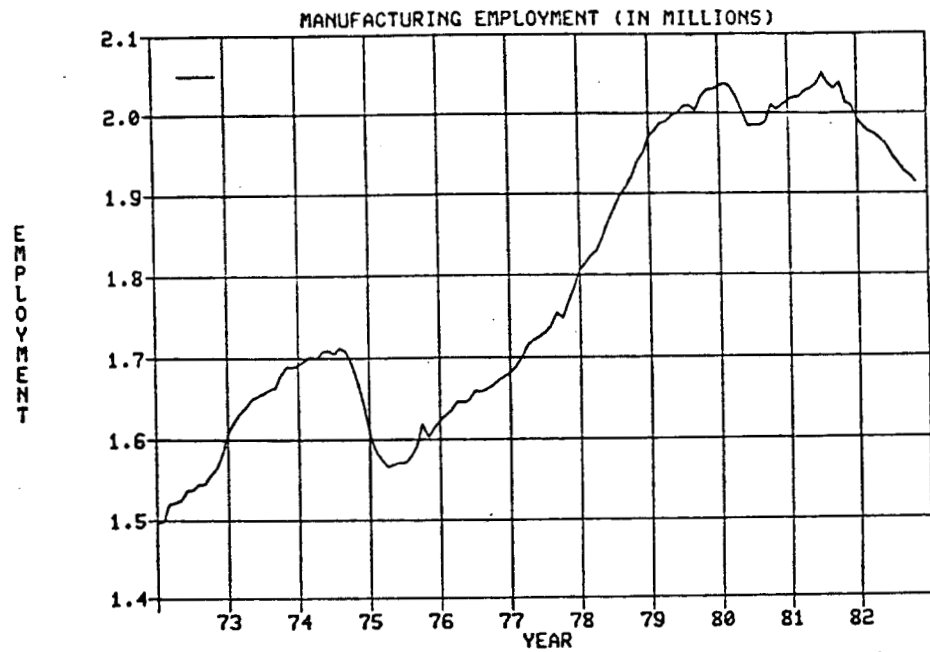


Figure 3 California Unemployment(18)

Table 2

WEATHER COMPARISON

1958-1982
ANNUAL HEATING DEGREE DAYS*

	San Francisco Federal Office Building	Los Angeles Civic Center	San Diego Lindbergh Field
1958	2332	849	805
1967	2978	1040	1380
1968	2942	850	1052
1969	3066	941	1137
1970	3006	941	1137
1971	3468	1424	1657
1972	3240	918	1166
1973	3161	1066	1137
1974	3182	1084	1123
1975	3313	1548	1416
1976	2665	1128	793
1977	2888	911	747
1978	2599	1208	736
1979	2545	1160	902
1980	2799	597	590
1981	2819	506	573
1982	3195	975	913
Normal			
1941-70	3080	1245	1507

*Source Local Climatological Data, for San Francisco, Los Angeles, and San Diego.

National Oceanic and Atmospheric Administration
National Climatic Center
Asheville, N.C.

California oil production set an all time high of 401 million barrels.⁽⁷⁾ Increases were largely related to increased production in offshore fields (Hondo and Beta), enhanced heavy oil production and the continued high production from Elk Hills (Naval Petroleum Reserve No. 1). The latter field produced 60 million barrels, some 15% of California's total oil production, but decline had set in at the end of 1981. Comparable records were not set in indigenous natural gas production, and production decreased slightly from 1981 levels.

Use of fuels for transportation dropped significantly (Table 3) including bunkering fuels. Gasoline use appears to have remained at 1980 levels, nonetheless, substantially below 1978-9 levels. The effect of fuel conserving smaller cars in the state's fleet is not easy to discern since population increases estimated at 500,000 and the effects of the recession are also reflected in the data.

At the instigation of the California Energy Commission the State moved ahead with plans to operate a fleet of methanol-fueled cars. 506 Ford Escorts are on order and 32 fueling stations are to be built.

Natural gas again was the largest single source of electrical power in 1982. Next in importance was California and out-of-state hydro power which reflected on the heavy rainfall on the Pacific coast during the 1981-2 winter. Nuclear power remained substantially below 1979 levels due to equipment failure at the two licensed plants in the state (Rancho Seco near Sacramento and San Onofre 1 in southern California). San Onofre Unit 2 (1100 MW_e) was loaded and granted a low power license in the Spring. Malfunctions and allegations that substandard welds had been used at San Onofre resulted in a one month investigation by the Nuclear Regulatory Commission and failure to reach full power in 1982. Unit 2 is shared by four utilities (Southern California Edison, San Diego Gas and Electricity, City of Anaheim and City of Riverside). Unit 3, also 1100 MW_e, is scheduled to reach criticality in 1983.

Table 3
Transportation End Use (10¹²Btu

	<u>1978</u> ⁽⁴⁾	<u>1979</u> ⁽⁵⁾	<u>1980</u> ⁽⁶⁾	<u>1981</u> ⁽⁷⁾	<u>1982</u>
Net Gasoline	1500	1439	1375	1384	1345
Net Aviation Fuel	357	350	346	335	298
Taxable diesel fuel-Public Highway	149	161	160	166	161
Rail diesel	35	35	43	46	42
Net Bunkering	288	358	430	412	346
Military	<u>30</u>	<u>30</u>	<u>32</u>	<u>42</u>	<u>36</u>
Total	2359	2373	2386	2385	2228

Source: 1982 data from Petroleum Supply Annual, 1982, DOE/EIA-0340 (82)/1 (June 1983) and Fourth Quarter 1982, Quarterly Oil Report, California Energy Commission, for net gasoline use.

Diablo Canyon nuclear power plant that was stopped short of fuel loading in 1981 by disclosure of engineering design and construction errors was still not fuel loaded by year end. The Humboldt Bay-3 nuclear plant (63 MW_e), out of operation for seven years, probably will be decommissioned since seismic modifications are believed to be too expensive to allow a return on the investment.

California utilities continue to be committed to buy power from sources fueled by renewable resources. Perhaps 10% of Pacific Gas & Electric Company new generating capacity will come from that source during the next decade. By 1982 the company had signed contracts to purchase 885 MW_e from 35 cogeneration and solid waste facilities (409 MW_e), three wind farms (382 MW_e), nine small hydro-plants (81 MW_e) and 48 windmills. In 1982 about 169 MW_e new cogeneration facilities came on line, the largest of which were Kerr-McGee Chemical Company (65 MW_e) and Crown-Zellerbach (46 MW_e). The state's total nameplate electrical capacity was on the order of 39 MW_e in 1982.

By the end of 1982 the largest solar power plant in the world was in operation by Southern California Edison Company and Los Angeles Water and Power on a 130 acre site southeast of Barstow. The 10 MW_e unit consists of 1818 mirrors concentrically arranged around and focused on a boiler atop a 255 foot tower. The Department of Energy underwrote most of the cost of the \$141 million test facility.

More geothermal capacity (110 MW_e) went on line at Pacific Gas and Electric Company's Geysers steam power plant to bring the total to 1018 MW_e. By 1988 the capacity is expected to be over 1500 MW_e.⁽¹⁹⁾

Comparison with U.S. Energy Use

We present the 1982 U.S. Energy Flow diagram in Figure 4 because of the marked contrast between it and that for the State of California (Figure 1). Some of the historical reasons for the differences were previously summarized (7), viz. the presence of a large petroleum industry in the state, environmental constraints on fuels for electric power production, make-up of economic structure of the state and evolution of a large road system for motor vehicles. Transportation alone accounts for 37% of all energy use in California. Coal has little use in the state except as coke in the steel industry. In 1982 the recession as well as price-driven conservation affected energy use in the U.S. as well as California. Preliminary data suggest that the combined effect was slightly greater in California (down 5.4%) than in the U.S. as a whole (4.4%).

U. S. ENERGY FLOW — 1982

(NET PRIMARY RESOURCE CONSUMPTION 70 QUADS)



Net hydroelectric 1.06

Net geothermal & other 0.02

Nuclear 3.1

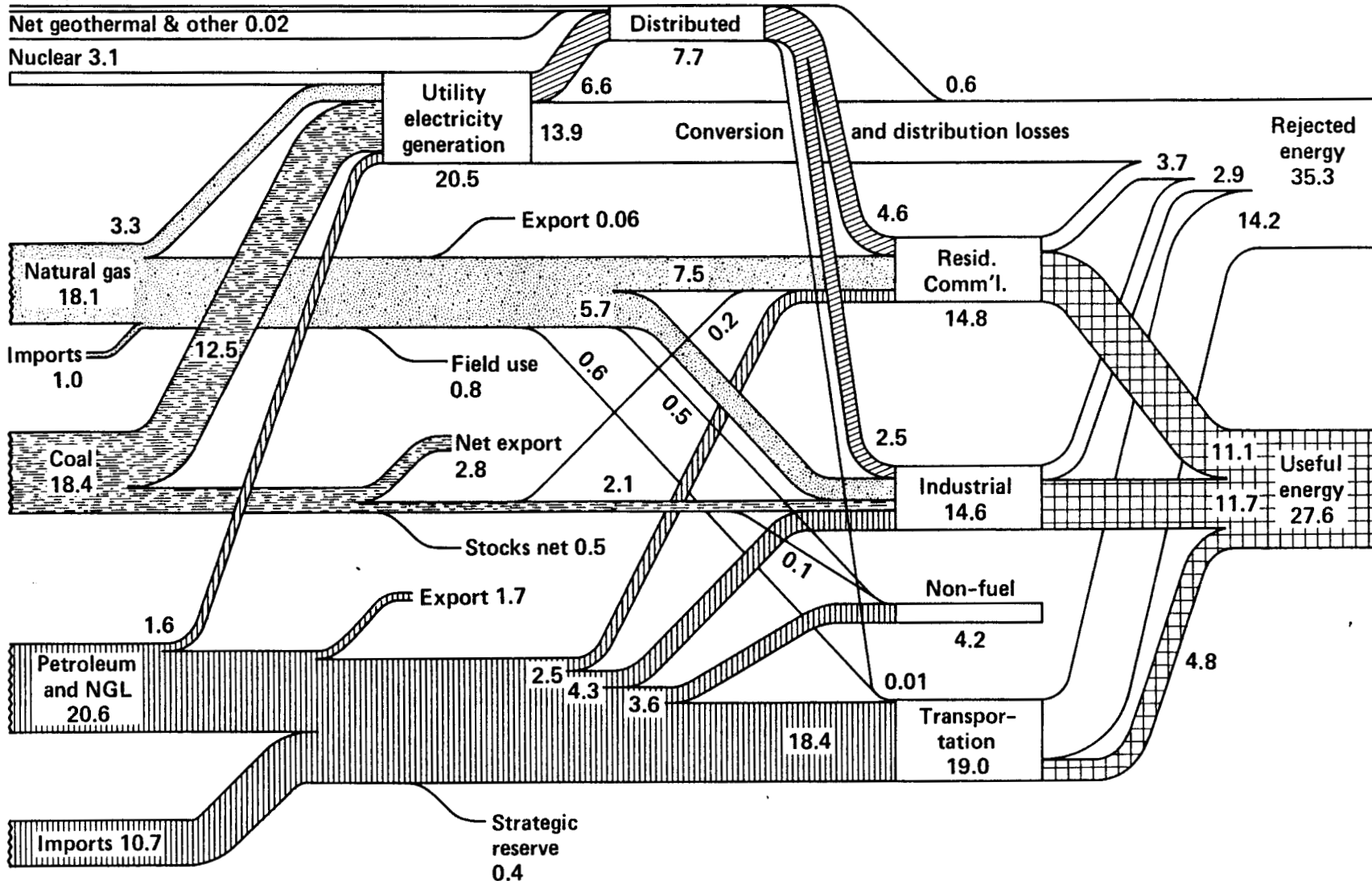


Figure 4

Appendix A

Data Sources for California Energy Supply (1982)

Production

Crude Oil including Federal Offshore and Lease Condensate	Ref. 8
Associated and Nonassociated Natural Gas	Ref. 8
Electrical Generation (hydro, coal, nuclear, oil, gas, geothermal)	CA. Hydro, Ref. 9, Table 31. Nuclear, Ref. 9, Table 30. Oil and Gas, Ref. 9, Tables 62,63. Geothermal, Ref. 9, Table 32.

Imports

Natural Gas Foreign and Domestic	Ref. 10, Table 2
Crude Oil Foreign and domestic	Ref. 11, Table I-8
Oil Products Foreign and Domestic	Ref. 11, Table I-7
Coal	Ref. 12, Table 22
Electrical Power	Ref. 10, Table 1

Exports

Oil Products Foreign and Domestic	Ref. 11, Table I-7
(not including bunkering fuel supplied at California ports)	

Appendix B

Data Sources for California End Uses (1982)

Net Storage and Field Use

Natural Gas

Ref. 10, Table 2

Transportation

Crude Oil

Consumption of gasoline,
aviation and jet fuels

Ref. 13, Table 2

Taxable diesel fuel (i.e. for
public highways)

Ref. 14, p. 137

Vessel Bunkering
(includes international bunkering)

Ref. 14, p. 136, 139

Rail diesel
Military Use

Ref. 14, p. 136

Ref. 14, p. 136, 138

Natural Gas
Lost or unaccounted for from gas
utilities (transmission
and pipelines)

Ref. 10, Table 2

Industrial, Government, Agriculture, etc.

Natural gas

By difference

Coal

Ref. 12, Table 22

Electricity

Ref. 15

Crude Oil

By difference

Non Energy Applications

Crude Oil and LPG

Asphalt

Ref. 16

Petrochemical feedstock

Ref. 14, p. 121

Waxes, lubricating oils,
medicinal uses, cleaning

1/3 of asphalt and road oil
totals, Ref.2

Natural Gas
Fertilizer

Ref. 17

Residential and Small Commercial

Natural Gas

Ref. 10, Table 2.

Crude Oil and Other Oils
(Kerosene, Residual, and Distillate)

Ref. 14, p. 135, 138, 140

LPG

Ref. 14, p. 121

Miscellaneous "off highway" diesel

Ref. 14, p. 137

Electricity

Ref. 15

Appendix C
Conversion Units

Energy Source	Conversion factor, 10 ⁶ Btu
Electricity	3.415 per MW.h
Coal	22.6 per short ton
Natural Gas	1.05 per MCF
LPG	4.01 per barrel
Crude Oil	5.80 per barrel
Fuel Oil	
Residual	6.287 per barrel
Distillate, including diesel	5.825 per barrel
Gasoline and Aviation Fuel	5.248 per barrel
Kerosene	5.67 per barrel
Asphalt	6.636 per barrel
Road Oil	6.626 per barrel
Synthetic Rubber and Miscellaneous	
LPG Products	4.01 per barrel

Assumed Conversion Efficiencies of Primary Energy Supply

Electric power generation	
Hydro power	90%
Coal	30%
Geothermal	18%
Oil and Gas	33%
Uranium	32%
Transportation Use	25%
Residential/Commercial Use	70%
Industrial Use	75%

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Available from
National Technical Information Service
U.S. Department of Commerce
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